Fish Movements onto and off the Floodplain

Expectation:	A significant increase in flux of fishes between the river channel and floodplain.
Author:	J. Lawrence Glenn, III, South Florida Water Management District
Date:	March 8, 1999; Revised June 2001.
Relevant Endpoint(s):	Restoration - System Functional Integrity - Habitat Quality Restoration - System Functional Integrity - Habitat Use Restoration - System Functional Integrity - River/Floodplain Interactions
Baseline Conditions:	Channelization of the Kissimmee River led to the drainage of approximately 12,000 hectares of floodplain wetlands. Current floodplain habitats are devoid of substantial water level fluctuations and lack ecological connectivity with the river (except during rare flood conditions). Hence, the historic flux of forage fishes and larval, juvenile, and adult large-bodied fishes between the river channel and floodplain typically does not occur. The baseline exchange rate within Pools A and C is assumed to be zero because discharge through C-38 or remnant river channels did not exceed rates required for overbank flow during the baseline period, except briefly during the El Nino event between December 1997 and March 1998. Flux of fishes between the river channel and floodplain may have occurred at this time, but was not documented.
Reference Conditions:	Historical data on river channel-floodplain flux within the Kissimmee River system are not available. Utilization of floodplain habitats by fishes is documented in block net samples collected by the Florida Game and Freshwater Fish Commission (1957). Consequently, reference conditions are derived from relevant data from the FGFWFC (1957) report and comparable river/floodplain ecosystems. Indirect evidence of river channel-floodplain flux is provided by age class distributions of large bodied species collected within historic floodplain habitats. Young-of-the-year and juveniles accounted for 98% of the centrarchids and esocids sampled within marsh habitats (FGFWFC 1957). These fishes were either spawned directly on the floodplain (indicating migration by gravid adults) or migrated onto the floodplain from riverine spawning grounds. A conceptual model of the pre-channelized river (Trexler 1995) suggests that fish community structure was driven by seasonal dynamics of floodplain inundation and exchange. Lateral movements by *Micropterus salmoides* (largemouth bass) and *Lepomis machrochirus* (bluegill) onto re-inundated floodplain habitats was documented in Pool B (Furse et al. 1996, Giles unpubl. data) during periods of high water. Both flood events were transient and associated with the Demonstration Project and 1997-1998 El Nino event, but showed that river channel fish species will utilize re-inundated floodplain habitats and indicates historic flux of fishes are possible.

The lower Mississippi River serves as a reference site for flux of fishes between the river channel and floodplain of the historic Kissimmee River because some fish species found in both rivers use inundated floodplain habitats when available. Guillory (1979) found 62 fish species utilizing inundated floodplain habitats of the lower Mississippi River, including 24 characteristic of the main channel. Three of the main channel species (*Dorosoma patenense* - threadfin shad, *Ictalurus punctatus* - channel catfish, *Notemigonous crysoleucas* - golden shiner) occur within the Kissimmee River and were collected within historic inundated floodplain habitats (FGFWFC 1957).

Exchange rates of fishes between river channel and inundated floodplains have been documented within two North American rivers. Kwak (1988) collected 23 species of fishes moving between the channel and two floodplain habitats (ephemeral ditch, permanent pool) of the Kankakee River, Illinois. Exchange rates approximated 0.08 fish/hour (number of fishes collected = 400, trap hours = 4,800). Numerically dominant families included Centrarchidae (35.8%), Esocidae (31.3%), Aphredoderidae (11.5%), Ictaluridae (9.3%), and Cyprinidae (5.8%). Ross and Baker (1983) found 17 species moving between channel and floodplain habitats along Black Creek, Mississippi, a blackwater coastal plain stream. Rate of fish exchange was 0.4 fish/hour (number of fish collected = 393, trap hours = 1000). Centrarchids (73.3%) and Cyprinids (17.3) were the dominant fishes collected. Juveniles made up 100% of all large-bodied species collected.

Mechanism relating restoration:

Re-establishment of historic hydrologic characteristics will drive the initial restoration of floodplain habitats and associated restoration of river channel-floodplain exchange. Restored floodplain habitats are expected to sustain fish assemblages structured similarly to those occurring within the pre-channelized system. Restoration of floodplain fish populations will be driven by appropriate inundation depths, increased dissolved oxygen levels, re-establishment of the forage base, and physical structural components (Lowe 1986, Heck & Crowder 1991, Connolly 1994, Jordan et al 1996, 1998). Lateral movements (passive and active) of fishes onto and off re-inundated floodplain habitats requires sufficient water depths (≥ 50 cm for large-bodied species; F. Jordan pers. comm.) and fluctuations (Welcomme 1979).

Adjustment for External Constraints:

None

Time Course:

Exchange rates are expected to increase significantly immediately following floodplain inundation as fish begin using newly inundated floodplain habitats, especially within habitats lacking established emergent wetland vegetation (i.e., pasture). River channel-floodplain exchange rates should continue to increase through time, stabilize, and then fluctuate seasonally/annually. Restoration time frames may require adjustment if appropriate hydrologic, abiotic, and biotic criteria are not met or are delayed.

Means of evaluation:

Sampling of river channel-floodplain flux of fishes will begin immediately following floodplain inundation to a depth of 50 cm. Large-bodied fishes will be collected using a series of frame nets (modified hoopnets) with 33 foot lead net runners. Three sets of

paired nets will be deployed within the floodplain at 10 and 250 m from the river channel. Nets will be positioned on the floodplain running parallel to the river channel to provide data on direction of fish movement (onto/off of floodplain). Sampling will be conducted biannually (upward and downward legs of hydrograph with a minimum inundation depth of 50 cm) within two habitats (existing broadleaf marsh, newly inundated pasture) in Pools A and C. Larval and forage fish will be sampled using paired drift nets or breeder traps placed at the same locations as frame nets. All nets will be set for 96 hours and checked twice daily (dawn and dusk). Exchange rates will be calculated as the total number of fishes collected divided by total trap hours.

Data from both sampling protocols will be analyzed for species composition and richness, relative abundance of functional groups (game fish, catfish, rough fish, forage fish), relative abundance of size classes of functional groups, and rate of exchange onto and off the floodplain. Differences in these data within like habitats between pools will be determined using ANOVA.

Table 1: Fish species collected by FGFWFC (1957) in pre-channelized marsh.

GAME FISH:		
	Centrarchidae	
	Micropterus salmoides	largemouth bass
	Lepomis auritrus	redbreast sunfish
	Lepomis machrochirus	bluegill
	Lepomis gulosus	warmouth
	Lepomis microlophus	redear sunfish
	Lepomis punctatus	spotted sunfish
	Pomoxis nigromaculatus	black crappie
	Esocidae	
	Esox americanus	redfin pickerel
CATFISH:		
	Ictaluridae	
	Ameiurus catus	white catfish
	Ameiurus nebulosis	brown bullhead
	Ictalurus punctatus	channel catfish
FORAGE FISH:		
	Aphredoderidae	
	Aphredoderus sayanus	pirate perch
	Atherinidae	
	Labidesthes sp.	silverside
	Menidia beryllina	inland silverside
	Centrarchidae	
	Elassoma evergladei	Everglades pygmy sunfish
	Ennecanthus gloriosus	blue-spotted sunfish
	Clupeidae	
	Dorosoma patenense	threadfin shad
	Cyprinodontidae	
	Fundulus chrysotus	golden topminnow
	Fundulus seminolis	seminole kilifish
	Lacania goodei	bluefin killifish
	Notemigonous crysoleucas	golden shinner
	Notropis maculatus	tailight shinner
	Notropis petersoni	coastal shinner
	Ictaluridae	
	Noturus gyrinus	tadpole madtom
	Percidae	
	Etheostoma fusiforme	swamp darter
	Poeciliidae	
	Gambusia holbrooki	eastern mosquitofish
	Heterandria formosa	least killifish
ROUGH FISH:		
	Catostomidae	
	Erimyzon sucetta	lake chubsucker
	Clupeidae	
	Dorosoma cepedianum	gizzard shad
	Lepisosteidae	
	Lepisosteus platyrhincus	Florida gar

LITERATURE CITED

Connolly, R. M. 1994. The role of seagrass as preferred habitat for juvenile *Sillaginodes punctata* (Cuv. And Val.) (Sillaginidae, Pisces): habitat selection or feeding? Journal of Experimental Marine Biology and Ecology, 180:39-47.

Florida Game and Fresh Water Fish Commission. 1957. Recommended program for Kissimmee River Basin. Florida Game and Fresh Water Fish Commission, Tallahasee, Florida.

Furse, J. B., L. J. Davis and L. A. Bull. 1996. Habitat use and movements of largemouth bass associated with changes in dissolved oxygen and hydrology in Kissimmee River, Florida. Proc. Ann. Conf. Southeast. Assoc Fish and Wildl. Agencies. 50:12-25.

Guillory, V. 1979. Utilization of an inundated floodplain by Mississippi River Fishes. Florida Scientist. 42(4):222-228.

Harris, S.C, T.H Martin and K.W. Cummins. 1995. A model for aquatic invertebrate response to Kissimmee River restoration. Restoration Ecology. 3(3):181-194.

Heck, K. L., Jr. and L. B. Crowder. 1991. Habitat structure and predator-prey interactions in vegetated aquatic systems. pg. 281-299. In S. S. Bell, E. D. McCoy and H. R. Mushinsky (eds.) Habitat Structure: the Physical Arrangement of Objects in Space. Chapman and Hall, New York, NY, USA.

Jordan, F., M. Bartolini, C. Nelson, P. Patterson and H. Soulen. 1996. Risk of predation affects habitat selection by the pinfish *Lagodon rhomboides.* Journal of Experimental Marine Biology and Ecology, 208:45-56.

Jordan, F., K. J. Babbit and C. C. McIvor. 1998. Habitat use by freshwater marsh fishes in the Blue Cypress Marsh Conservation Area, Florida. Ecology of Freshwater Fish. &:159-166.

Kwak, T. J. 1988. Lateral movement and use of floodplain habitat by fishes of the Kankakee River, Illinois. American Midland Naturalist. 120(2):241-249.

Lowe, E. F. 1986. The relationship between hydrology and vegetational pattern within the floodplain marsh of a subtropical, Florida lake. Florida Scientist. 49:213-233.

Milleson, J.F. 1976. Environmental responses to marshland reflooding in the Kissimmee River basin. Tech Pub. 76-3. South Florida Water Management District, West Palm Beach, Florida.

Ross, S. T. and J. A. Baker. 1983. The response of fishes to periodic spring floods in a southeastern stream. American Midland Naturalist. 109(1):1-14.

Toth, L.A. 1991. Environmental responses to the Kissimmee River demonstration project. Tech Pub 91-02, South Florida Water Management District, West Palm Beach, Florida.

Trexler, J. C. 1995. Restoration of the Kissimmee River: A conceptual model of past and present fish communities and its consequences for evaluating restoration success. Restoration Ecology. 3(3):195-210.

Welcomme, R. L. 1979. Fisheries ecology of floodplain rivers. Longman Group Limited. London, England.